**Small Business Innovation Research/Small Business Tech Transfer**

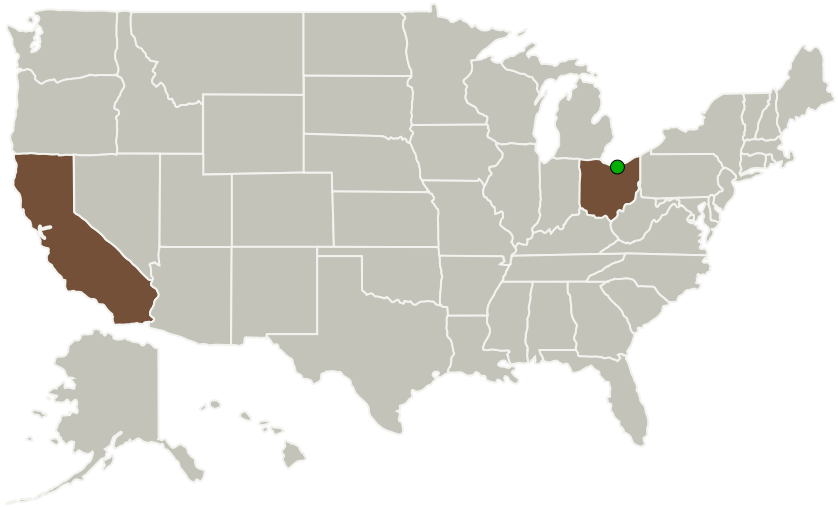
# Physics-Based Radiator Design, Sizing & Weight Estimation Tool for Conceptual Design of More-, Hybrid-, and All-Electric Next Gen Aircraft, Phase I

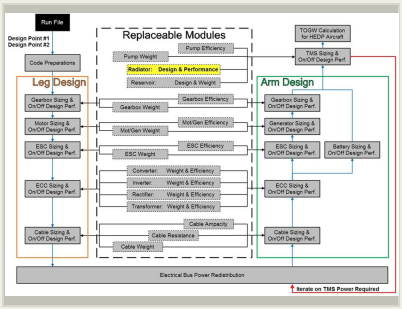
Completed Technology Project (2014 - 2014)

## Project Introduction

Hybrid electric distributed propulsion (HEDP) systems have proven worthy for further consideration by approaching NASA's goals for N+2 and N+3 energy consumption, noise, emission and field length. The thermal management associated with these systems has been recognized as a major challenge to be overcome. ESAero's recent 2012 Phase I SBIR (NNX13CC24P) identified the radiator as a driving component within the thermal management system (TMS). Its design has profound first order effects on the weight, performance, and aerodynamic drag of the TMS, and second order effects on the weight and performance of the overall propulsion system. During the proposed Phase I SBIR, ESAero will upgrade the existing physics-based radiator design, analysis, and weight estimation conceptual design tool by improving the flexibility and fidelity of thermodynamic analysis and predicting the effects of integrating the radiator core within a well-designed duct. ESAero will call upon existing techniques to design a robust tool that more accurately predicts the "as-built" behavior of the component. These modifications are expected to dramatically improve the predicted weight and performance of the radiator and negate nearly all of the radiator drag by employing the Meredith Effect, as seen on the P-51 Mustang.

## Primary U.S. Work Locations and Key Partners






Physics-based Radiator Design, Sizing & Weight Estimation Tool for Conceptual Design of More-, Hybrid-, and All-Electric Next Gen Aircraft Project Image

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Completed Technology Project (2014 - 2014)

| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| Empirical Systems Aerospace, Inc.(ESAero) | Lead Organization | Industry | Pismo Beach, California |
| Glenn Research Center(GRC) | Supporting Organization | NASA Center | Cleveland, Ohio |

| Primary U.S. Work Locations | |
|---|---|
| California | Ohio |

## Project Transitions

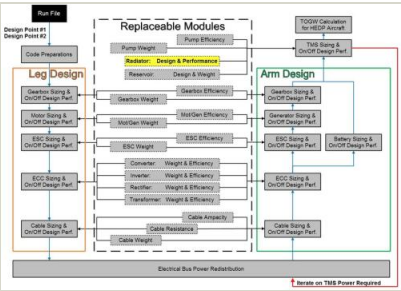
**June 2014:** Project Start

**December 2014:** Closed out

**Closeout Documentation:**

- Final Summary Chart*(https://techport.nasa.gov/file/137696)*

## Images




**Project Image**

Physics-based Radiator Design, Sizing & Weight Estimation Tool for Conceptual Design of More-, Hybrid-, and All-Electric Next Gen Aircraft Project Image *(https://techport.nasa.gov/image/133753)*

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Empirical Systems Aerospace, Inc. (ESAero)

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

Benjamin T Schiltgen

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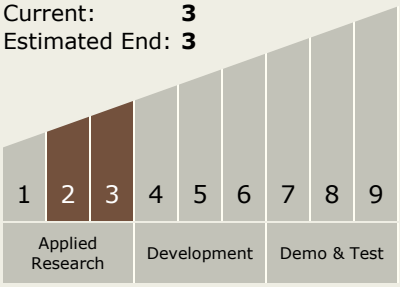
## Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**




## Technology Areas

**Primary:**

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.3 Heat Rejection and Storage

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System